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(54) Title: MACHINE READABLE RECORD

(57) Abstract: The invention relates to a machine readable record which involves data symbolic marks containing a summary constant number of dark elements through the whole record that consists of a record medium such as paper or other record printing substrate, of data symbolic marks printed on such record medium, arranged onto a grid on positions by periodically repeating characteristics in the horizontal as well as vertical direction, of text or graphic print printed in an overlay with data symbolic marks, of elements of record modulation by a graphic pattern.

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Machine readable record

Technical Field

The invention relates to a machine readable record, method of its preparation and usage. This method provides recording and reading of machine readable two-dimensional marks representing binary data placed on paper, eventually on other carrier, side, or overlaid by human readable data, or patterns.

This invention also involves a representation with such characteristics that the efficiency of dark pattern elements in a symbolic data mark for the representation of dual status is higher in comparison with the current practice.

The invention involves transparent protection of documents by means of machine readable two-dimensional marks that, if overlaid by the original print data of a document, carry the full data and secure information of electronic representation on paper and enable conversion of this information back in electronic representation free of losses, with the full reconstruction of the document.

It is possible to modulate the symbolic data marks by a pattern or line pattern provided such modulation doesn't disturb the resolution ability of the data symbolic marks.

Data representation is such that the number of dark elements is constant regardless of data represented by marks. The number of necessary dark elements for the same level of dual statuses recognition is smaller in comparison with the current practice.

Background Art

Methods of recording of machine readable marks on paper are very miscellaneous, what depends on the purpose of marks usage.

There are known multiply methods of the placing of marks readable by a human as well as by a machine (for instance machine readable cheques with appropriate shaped numerals).

In this group of recording were registered also trials to combine human and machine readable data representations for instance in US patent No. 5606628 : Apparatus and method for generating bit-mapped patterns of print characters.

There are developed two-dimensional representations in the group of methods using bar code, which methods include sophistic methods of self-correction and self-synchronising characteristics, see solutions for instance in US patent No. 4939354 „Dynamically variable machine readable binary code and method for reading and producing thereof", US patent No. 5337362 „Method and apparatus for placing data onto plain paper", US patent No. 3643068 „Arrangement for the automatic identification of information on a non perforated data processing card", US patent No. 4998010 „Polygonal information encoding article process and system", US patent No. 4692603 „Optical reader for printed bit-encoded data and method of reading same", US patent No. 4924078 „Identification symbol, system and method", US patent No. 5327510 „Method of recording/reproducing data of grid pattern, and apparatus thereof", US patent No. 5278400 „Multiple threshold encoding of machine readable code".

These techniques require their own separated area on a paper to record data marks on the paper, and are disturbing for human. The data capacity of a code is limited by the area allocated for the code.

Demand for machine readable record in conjunction with human readable data limits technology usage and resulted in "hidden" or "embedded" techniques.

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Some technologies of copyright protection enable data to be inserted in an original text or pattern (watermarking, steganography). These methods are limited what concerns of the volume of data inserted, and require large extent of calculations.

Here should be mentioned US patent No. 5636292 „Steganography methods employing embedded calibration data" and „Electronic marking and identification techniques for deterrent of copying document" by J. Brasil and collective, IEEI Infocom 94, 1278-1287.

Some technologies insert copyright or other information into the background of document by means of marks placed on selected background places for instance US patent No. 5568550 : Method and system for identifying documents generated by an unauthorised software copy, US patent No 5436974 Method of encoding confidentiality markings, US patent No 5917996 „System for printing tamper-resistant electronic form characters".

Techniques like those using wedge code are solved for instance by US patent No 3959631 „Wedge code and reading thereof".

These techniques led to more sophisticated techniques, to the group named as glyph representation of digital data. These techniques are more developed what concerns of data embedding in a larger paper area (or other substrate) for instance see US patent No. 4754127 „Method and apparatus for transforming digitally encoded data into printed data strips", US patent No 5245165 „Self-clocking glyph code for encoding dual bit digital values robustly", US patent No 5091966„Adaptive scaling for decoding spatially periodic self-clocking glyph shape codes, US patent No 5168147 „Binary image processing for decoding self-clocking glyph shape codes", US patent No 5315098 „Methods and means for embedding machine readable digital data in halftone images", US patent No 5486686 „Hardcopy losses data storage and communications for electronic document processing systems".

However, neither these techniques are transparent in regard to the usable document area, and they aren't transparent in regard to application. Human and machine readable document forms are placed on their own dedicated places and don't overlap each other. Freedom of printable document area usage is principally restricted.

It exists one requirement, machine readable data representation is to be minimally disturbing for a human - reader, scattered data marks are to be of a minimal possible contrast and even grey level sensed subjective by a reader.

The referred invention is based on such representation of digital data dual status that elements dedicated for the representation of the complementary binary values dual status are placed in distant places in regard to the axes of symmetry of the place of a two-dimensional mark..

The requirement of an even integral density level of dark elements excludes some forms of representation which change the contents of the dark elements of a mark according to a represented logical value. Likewise, such representations are excluded, which use forms not suitable for accurate localisation of mark's position (for instance round forms).

Each element participating on whole representation of dual binary values is placed on such position that its distance to one or two axes of symmetry of a symbolic data mark (FIG. 1, FIG. 2, FIG. 3, FIG. 14) is the maximal possible one.

Analysis showed that the form and location of the dark elements of a symbolic data mark significantly influence its characteristics for determination of its accurate location during reading of symbolic data marks and thereby the quality and stability of the process of mark reading in an ambient with severe noise and geometrical distortions of printing and scan process.

With respect to the above mentioned, it is helpful to define some bearing lines on the body of a mark in both directions to enable an as easy and stable algorithm of correction of the expected mark position as possible. Such lines for one preferred execution are for instance lines parallel to lines of equal distance to both axes of symmetry of a mark.

With respect to this, it is helpful to place dark points onto an interval given by their maximal distance to an equidistant line to both axes of symmetry.

So, the location of dark elements is given by three basic limitations: the maximal aggregate of distances to both the axes, maximal allowed distance to both the axes of symmetry and boundaries of the area allocated for a symbolic data mark (FIG. 2b, FIG. 3 and 11b).

Analysis showed also that the dark elements of a symbolic data mark, which are placed close to an axis of symmetry of this mark are merely invariant, so that they don't increase the discriminability of the binary values represented by the symbolic data mark but contribute to the total integral value of the dark elements of such representation only.

This part of the area dedicated for mark representation can be used for placement of dark elements according to the value of modulation performed by a pattern or graphic information (FIG. 12).

Other method of modulation represents increasing of the number of dark elements by their addition to another mark elements in free locations most outlying to the axes of symmetry of the area of a mark (FIG. 13).

The aggregate of dark elements shall be minimal, but not lower than the threshold value which affect the discriminability of the binary status represented thereby.

For each chosen maximal number of dark elements appropriated to one symbolic data mark is given an optimal position of the location of these elements on the most outlying free location of the area of a mark in regard to the axes of symmetry of the area of the mark.

Disclosure of the Invention

The subject of the method of recording, determination of the location and number of dark elements for coding of dual represented statuses in a symbolic data mark for data recording and reading on paper or other carrier of such mark, wherein these dark elements represent on an area available for one symbolic mark two statuses of a constant number of dark elements that position varies only, consists therein that it includes:

Determination of the axes of symmetry of a two-dimensional area dedicated for a symmetric data mark and determination of a co-ordinate system in regard to these axes of symmetry.

Determination of the aggregate area of the mark i.e. the number of dark elements used for coding of two statuses for data representation on an area allocated for the symbolic data mark.

Determination of the maximal allowed distance of dark points to a line of equal distance to both the axes of symmetry and minimal allowed distance to each of the axes of symmetry.

Calculation of the aggregate of the absolute values of both co-ordinates for each possible location of a dark element.

Determination of the areas of the maximal distance to both the axes in compliance with the aggregate calculated in step 1.4, and condition resulted from step 1.3.

Recording of one a half of the maximal allowed number of elements in one of the areas determined in step 1.5 within the limits of the area allocated for the symbolic data mark, which recording represents one a half of a symbol representing one of the two statuses which could be represented by the symbolic data mark.

Recording of the second half of the maximal allowed number of elements in a next of the areas determined in step 1.5, laying on opposite side of both the axes of symmetry, within the limits of the area allocated for the symbolic data mark as one a half of the symbol representing one of the two statuses which could be represented by the symbolic data mark.

Choosing of the locations of dark elements located symmetrically to the second symmetry axis with respect to the elements described in step 1.6 and 1.7 as the locations of elements representing the second status of the two representing the symmetric data mark.

Determination of the areas of maximal distance to each of the symmetry axes individually.

Recording of the maximal allowed number of elements in one of the areas determined in step 1.9 within the limits of the area allocated for the symbolic data mark as a symbol representing one of the two statuses which could be represented by the symbolic data mark.

Choosing of the locations of dark elements located symmetrically to such axis of symmetry that doesn't intersect the chosen locations of dark elements with respect to the elements chosen in step 1.10 as the locations of the elements representing the second status of the two represented by the symbolic data mark.

The subject of this invention also consists in a method of recording of symbolic data marks by means of dark and light elements placed on a paper or similar carrier of print information, which includes:

Definition of a grid of two systems of axes, a horizontal one and a vertical one, perpendicular to each other with an even or different relative distance in horizontal and vertical directions, on a paper area dedicated for recording of symbolic data marks.

Determination of a maximal allowed number of dark elements for a symbolic data mark.

Such placing of one system of symbolic data marks onto the area of lines connecting two intersections of each horizontal axis with vertical axes, that a one logical status represented by the symbolic data mark has the majority or all of its dark elements placed on one a half of the mentioned connecting line or close to it and the second logical status represented by the symbolic data mark has the majority or all its dark elements placed on the second half of the mentioned connection line or close to it.

Such placing of the second system of symbolic data marks in the area of lines connecting two intersections of each vertical axis with horizontal axes so that a one logical status represented by the symbolic data mark has the majority or all of its dark elements placed on one a half of the mentioned connecting line or close to it and the second logical status represented by the symbolic data mark has the majority or all its dark elements placed on the second half of the mentioned connection line or close to it.

Placing of dark elements to positions maximal outlying to the centre of a line connecting intersections of the two systems of axes.

Such placement of the dark elements of the mark, that they are minimally v value distant from the mentioned intersections of the horizontal and vertical axes.

Such placement of the dark elements of the mark, that they are maximal d value distant from a line connecting intersections of the horizontal and vertical axes.

The subject of the invention involves also a method of a transparent protection of a document dedicated for printing, which is transparent in regard to an application as well as to the document data contents by means of a field of symbolic data marks particular according to the claims 1 or 5, wherein this field is printed overlaid by the print of the proper document, wherein this protection provides a selective data and security continuity of electronic and paper document in both directions i.e. from electronic version of a document to a form printable on paper and from the paper form of the document back to the electronic version of the document, which method consists of:

Extracting of such part of the data contents, that is dedicated for document protection, that can include also a positional information on the printed document, from a file dedicated for print by an original application.

Extracting of other document contents including also invariable data for a set of documents of the same kind, from the file dedicated for print by the original application.

Transformation of the data extracted in the first eventually also second step according to algorithms including also cryptographic, compress algorithms and procedures, electronic signature, self corrective coding and data preparation for mark modulation by a graphic information.

Transformation of the data from step 15.3 to a form suitable for printing of a field of two-dimensional symbolic data marks representing the mentioned data as described e.g. in other items of this invention, but not limited on such, arranged in rows and columns, placed on a printing document on its substantial area, principally independent of the area used for the print of the original document the full file data of which were used as the input of step 15.1.

Printing performed by overlaying of the print of the original document which is printed concurrently or in time sequence with the print of two-dimensional data symbol marks on one substrate, mostly on paper.

Scanning of this printed protected document by a scanner or other similar equipment and input of the scanned data into a computer.

Processing of the read data of the mutually overlaid print of the original document by the field of symbolic data marks, recognising, extraction of the data represented by the field of symbolic data marks.

Transformation of the recognised and extracted data by a set of algorithms including also cryptographic, decompress algorithms and procedures, electronic signature, self corrective coding (decoding).

Visualisation of these recognised and processed data, i.e. the part of the data contents determined for protection.

Linking of the recognised and processed data of step 15.8 with the data of other document contents of step 15.2 till to a full reconstruction of the file document in its complete form as it was used for the purposes of items 15.1 and 15.2, however not limited on the complete form only.

Visualisation of the complete document on a visualising equipment.

The invention relates also to a machine readable record which includes also data symbolic marks containing an aggregate constant number of dark elements in the whole record, and which consists of:

-   record media like paper or other record printing substrate,

- data symbolic marks printed on the record medium, arranged onto a grid on positions by periodically repeating characteristics in horizontal as well as vertical direction,
- text or graphic print printed in an overlay with data symbolic marks,
- elements of a record modulation performed by a graphic pattern.

The subject of the invention involves also a system for data recording on paper, or other carrier and reading of machine readable marks which consists of:
- means for transformation and formatting of source data to a sequence of digital data embedded in individual symbolic data marks,
- means for coding of such data sequence onto a format consisting of a description of a symbolic data mark in the language of the used printing method,
- means dedicated for printing of a record on paper or other printing substrate,
- means for reading of data symbolic marks from paper or other carrier onto a computer,
- means for transformation of the read data of the data sequence format which are represented by individual symbolic data marks.
- means for transformation to the format of the data which were the source of symbolic data marks recording or to other chosen format,
- means for modulation of marks by a source graphic pattern.

The submitted invention will be described in the next text in connection with preferred executions of the invention, however it is evident that the invention isn't narrowed and limited on these executions only. Vice versa, the intention is to cover all such alternatives, modifications and equivalents which could be included in the sense and scope of the invention defined in the attached part of claims. A record on paper as a method suitable for machine reading is optimised basically from three points of view. What concerns of the density of recorded data on a unit area, further what concerns of the reliability thereof, the velocity of the reading process thereof, its resistance against disturbing influences which include geometrical distortions during print process, distortions during reading process (scanning) and a presence of a disturbing noise such as distortions of detail printing, or a presence of other print overlaying recorded data marks, or subsequent damage of recorded data parts.

The third point of view represents such feature of marks selected for data representation, which makes these marks less disturbing for a reader, doesn't claim an allocated reserved area of the printed document which is dedicated for data only and is tolerant to an overlay by a normal text print in regard to its normal readability and machine readability of marks.

An increased record density imposes increasing demands on accurate localisation of data representing marks, demands on recognition of represented logical data marks. Therefrom results the importance of a marks feature enabling permanent position feedback during reading of individual marks under such condition that their dimensions are already comparable, or smaller than the allowances and distortions of print and scan process. An increasing record density leads to increased calculation demands during the process of recognising of their recorded logical status.

The forms of marks and the locations of their components must allow recognition of the marks by few steps but robust algorithms enabling even fast and simple correction of their expected position and resistance against failures of a larger extent.

Mostly, the area allocated for the representation of an elementary mark carrying dual binary data mostly is of a rectangular shape in a two-dimensional area. It results from the fact that we embed a maximum data available in a total area available by means of a form of a rectangle grid of symbolic data marks.

The most famous methods are based on the area characteristic of marks and not on brightness characteristics.

In the case that the goal shall be a co-existence of a printed text with data marks on the same area in an overlay, it is set such requirement of a homogenous appearance of a data marks field on the substrate of the printed text, that a reader will be not disturb by their summary level during a recognition of the text or other printed patterns, which level will include for instance from 5% to 15% of maximal dark elements in the total available printing area.

The submitted invention uses in its one own aspect the fact that under keeping of the total number of dark elements, a record of dark elements shall be performed on possible most outlying alternative positions in regard to the axes of symmetry of an area dedicated for a mark.

One embodiment of the invention uses for marks recording symmetry to both axes of symmetry concurrently. The second execution uses for mark recording each symmetry axis individually.

Brief Description of Drawings

FIG. 1 and FIG. 2 show an area of a favourable location of dark elements. On FIG. 3 are given V_{cp} values for a possible location of dark elements on the area of a symbolic data mark the size of 10 x 10 elements. FIG. 4, FIG. 5 and FIG. 6 show possible configurations of dark elements. FIG. 7 and FIG. 8 show the location of dark elements according to the common technical practice. FIG. 9, FIG. 10 and FIG. 11 show various examples of a dark elements arrangement according to the invention. FIG. 12 shows an example of a dark element configuration for modulation of data symbolic marks by dark elements. FIG. 13 shows a next realisation of modulation by dark elements. FIG. 14 shows a next favourable embodiment according to the invention. FIG. 15 shows areas evaluated at reading a data symbolic mark sequentially in both directions by both axes of symmetry. FIG. 16 shows mark area modulation by dark elements placed in the surrounding of the intersection of the axes of symmetry, in an area not influencing on the discrimination quality of the mark. FIG. 17 shows a procedure using a separate protected path for a part of an information with a separate invariable standard contents (mask, blank form).

Best Mode for Carrying Out the Invention

A first embodiment according to this invention is shown on FIG. 1 and FIG. 2. Areas most outlying to both axes of symmetry along their either sides are situated in the ABCD areas in four corners of the area of the mark.

The weighing function of an elements location $V_{ep} = |C_x| + |C_y|$ gives for each location of a dark element a value which is the aggregate of the distances to both axes of symmetry (C_x and C_y represent element co-ordinates in regard to the individual axes).

FIG. 3 shows V_{ep} values for a possible location of dark elements on the area of a symbolic data mark the size of 10 x 10 elements.

Apparently, the elements of outlying corners are multiply · significant for discriminability of the binary statuses. An example of a mark realisation according to this invention is such that one status is given by a presence of dark elements in the most outlying corners of the area of the mark (A, D), and the second status is given by a presence of dark elements in other two corners (B, C) and an absence of dark elements in the second complementary corners of the area.

Other embodiment in agreement with this invention could be such that one status of a symbolic data mark is given by a presence of dark elements in outlying positions of the area A and outlying positions of the area B, and the second status is given by a presence of dark elements in areas of other two corners C and D and an absence of dark elements in the complementary areas (A and B). It is apparent that one status can be likewise represented by a presence of elements in the areas A and C and by an absence in the second two areas (B and D), and the second status by a presence of dark elements in the areas B and D and an absence in the areas A and C.

It is apparent that central located areas are less suitable for coding of various statuses and contribute to discrementability of these statuses minimally.

FIG. 4, FIG. 5, FIG. 6 show possible configurations of dark elements (there are shown one corner and a half of elements only), wherein the number of dark elements is a parameter (16 elements, 14 elements, 12 elements).

It is possible to assign the sum V_{ep} of participating elements for each shown configuration of dark elements and the efficiency of participating elements in regard to the discriminability E_D

$$E_D = \Sigma_i V_{ep}/\text{number of participating elements}$$

As shown on these pictures, for each number of maximal allowed dark elements is given an optimal arrangement of dark elements. FIG. 7 and FIG. 8 show the method used in the previous common technical practice and illustrate the small contribution of the central areas of a mark, but that significant one what concerns of filling of the number of maximal allowed dark elements.

FIG. 9, FIG. 10, FIG. 11 show various examples of realisation of an arrangement of dark elements according to the invention.

An example of the method of discrimination of two statuses of a symbolic data mark is shown on FIG. 11, that is based on adding of the quantitative values of an element scheme of two corners symmetrical to both axes and subtracting of the aggregate of the quantitative value of an element scheme of the two remaining areas symmetrical in regard to those previous by both axes.

The sign of the result refers the represented mark binary status. In some cases is more optimal to use a more complicated, but still computing simple procedure which gives a reliable result of the represented value and at the same time also a correction of the expected location of the area of a mark.

FIG. 12 show an example of a configuration of dark elements for modulation of an area of data symbolic marks by dark elements which in a total grid of data symbolic marks

represents a graphic pattern (for instance logo, state sign etc.). Modulating dark elements are recorded in this case to the central area of the mark and can be of various number according to the degree of modulation. These dark elements neither improve nor retrograde the discriminability of the represented status of the symmetric data mark. The number of grey scheme levels which can be recorded as a modulation is given by the maximal allowed element number for modulation.

FIG 13 shows such a next realisation of modulation by dark elements, that dark elements of modulation are added to the dark elements representing a logical value. Modulating elements contribute to a discriminability of two represented statuses of a mark thereby.

A next preferred embodiment in agreement with the invention is on FIG. 14, whereon two systems of data symbolic marks are shown, each uses symmetry by one symmetry axis. A next preferred embodiment in agreement with the invention is on FIG. 14 whereon two systems of data symbolic marks are shown, each uses symmetry by one axis of symmetry. Such an arrangement is favourable for determination of mark location correction and reading algorithm efficiency. The number of dark elements necessary for a representation of one bit is smaller then that one of the previous common technical practice.

FIG. 15 shows areas which are evaluated at reading of a data symbolic mark concurrently in both directions by both axes of symmetry.

FIG. 16 shows modulation of the area of a mark by dark elements located in the surroundings of the intersection of the axes of symmetry, in an area which doesn't influence on the discrimination quality of the mark.

Characteristics of symbolic data marks, the robustness of the algorithm of reading and initialisation thereof create the necessary qualification for feasibility of usage of a field of marks printed on one substrate as an overlay with the inherent document, relatively independent on its density. Printing of an inherent document as an overlay upon a field of marks carrying an information represents just disturbances in an information channel in a large scale. The submitted solution uses a selective extract of protected information from a file or other data source (generally all alphanumerical marks, with their positional information) which are processed, and then represented by a field of symbolic data marks. Repeated patterns and graphical shapes (for instance logo) are not changed in the given category, type of a document and can be transmitted by a single-shot, independent path. On the place of document reconstruction, after reading of the field of marks and their processing (for instance electronic signature, decryption etc.), this part will be combined with the invariable part (mask, blank form) in a whole corresponding to the original document visually, however with an acknowledged contents.

FIG. 17 shows a process using a separate protected path for a part of an information with a separate invariable standard contents (mask, blank form). Both parts will be merged on the place of reconstruction and verification.

Example 1

It is described a one favourable embodiment according to one aspect of the invention. A two-dimensional area dedicated for recording of symbolic data marks will be divided into a grid of horizontally and vertically repeating areas available for location of one mark. For a unit area available, a symmetry axis will be determined in horizontal as well as vertical direction. Lines of equal distances to both the axes of symmetry will be determined. The

maximal aggregate area of an unit symbolic data mark i.e. the maximal number of dark elements for representation of one logical status by a mark will be determined. For each possible position of a dark element, the aggregate of its distances to both the axes of symmetry will be determined.

The maximal allowed distances of dark elements to the lines of equal distances to the axes of symmetry will be determined. The areas of the maximal aggregate of the dark element distances to both the axes of symmetry will be determined.

One a half of the maximal number of dark elements will be recorded in one of four such areas so that the aggregate of their distances to both the axes to be the maximal one, and at the same time these elements to be not more outlying to the line of equal distances to the axes of symmetry than a maximal distance allowed by us and these elements to be recorded in the available area of a mark.

The second half of the maximal number of dark elements will be recorded in an area symmetrically located in regard to both axes of symmetry of the available area of the mark.

For representation of the second logical status, areas symmetrical in regard to one axis of symmetry of the available area of the mark will be used.

For purposes of modulation by a graphical or line pattern we place a number of dark elements appropriate to a modulation of one available mark area close to the intersection of the axes of symmetry of the available area of the mark.

During reading of such recorded marks, the status of four areas of the maximal distance to the expected axes of symmetry will be evaluated in regard to a presence of dark elements in an upper threshold number.

Comparing the number of the elements of two diagonally outlying areas with the number of those laying in areas symmetrical by one axis of symmetry, a first approximation of determination of the value represented by the mark will be obtained, a next approximation will be obtained by checking of a presence of the dark elements of couples of not diagonally located areas in a number over threshold value.

The value represented by the mark as well as the correction for the position of the next symbolic data mark will be obtained following the results of these comparisons and checks.

Localisation of the positions of the beginnings and ends of the rows and columns of the areas of symbolic data marks for this favourable embodiment will be performed by evaluation of the positions of image points in regard to a margin of the paper what concerns of the periodicity of the variation of the presence of dark points, where the first point having such characteristic determines one initial co-ordinate of the origin of the rows (columns).

Elimination of distortions of the beginnings of individual rows (columns) will be reached by creation of a curve that is a linear approximation of all found beginnings of rows (columns) and by placing a straight line parallel to such linear approximation and by a translation moving of such straight line till to its first contact with the linear approximation and subsequent rotation thereof around the subjected point till a second intersection is found. Further, the outlying points of the original collection of the found beginnings are filtered and a periodical concentration of points (clusters) is detected. This process will be repeated in other three directions from a margin of the paper and the perpendicularity and parallelism of resulting four straight lines will be detected, and the position of a not parallel (not perpendicular) straight line will be corrected following the findings as well as the position of the margins of marks will be determined according to three straight lines minimal.

Example 2

A second favourable embodiment of recording of symbolic data marks consists in utilisation of placing of dark elements symmetrically to a one axis of symmetry only. Two systems of axes, a horizontal one and a vertical one, perpendicular to each other, will be specified in the whole area specified for symmetric data marks. One system of marks will be placed on connection lines between the intersections of the first system of axes with the second system of axes and the second system of marks will be placed on the connection lines between the intersections of the second system of axes with the first system. The maximal number of dark elements appropriate for a representation of one status of a symbolic data mark will be specified. Dark elements will be recorded onto locations maximally outlying to the middle of a connection line of intersections, thus to the axis of the symmetry of the mark. Dark elements of marks will be such placed (recorded on the substrate) that all dark points of one logical status will be located on one a half of the mentioned connection line or close to it, where dark elements are of the minimal given distance to the intersections of axes and of maximal given distance to the connection line of the intersections. The second represented status has all or the majority of dark elements located on the opposite half of the mentioned connection line, with keeping the limitations of distances to connection lines and intersections. For this preferred embodiment, reading of recorded marks consists in evaluation of the status of areas on either sides from the middle of the connection line of intersections what concerns of a presence of dark areas, and the value represented by the symbolic data mark and one part of the correction of the mark location will be expressly determined by comparison of the quantitative values of the darks elements. Mutual comparison of the aggregates of the values of the dark elements of both the sides of the expected connection line of intersections gives one part of the correction of the mark location. These steps of mark reading will be performed for both the systems of marks. With this embodiment, modulation of the marks area will be performed by placing of an appropriate number of dark elements (according to the modulation intensity of the given point - in the given mark) close to the intersection of the axes of symmetry of the connection lines of the intersections of both the systems of axes.

With this favourable embodiment, localisation of the beginnings and ends of the rows (columns) of the areas of symbolic data marks will be performed such that a presence of dark points will be searched sequentially from a margin of the paper in individual scanned rows (pixels). In the next step, a linear approximation will be performed on all the first detected dark points in each scanned row, and all the points of the original collection, which are more distant from the straight line of this linear approximation than a distance objective specified, will be excluded. Consequently, a new linear approximation will be performed on the points that remained, and once more the points more distant than the distance smaller than that of the previous step will be excluded. This step will be repeated till the difference of the most outlying point to the straight line of the running linear approximation isn't less than the given minimum. The specification of nearest points will be performed likewise also in the remaining three directions. The first symmetric mark will be found on a straight line parallel to the straight line of the last linear approximation in the half distance of the vertical axes distance. Moreover, the location of the mark in the second direction will be obtained likewise.

Example 3

Following the next favourable embodiment, a transparent protection of a document specified for a printing will be performed, which protection uses data symbolic marks

according to other aspects of this invention, where the whole data form of the document or some parts thereof will be recorded on one printing substrate overlaid with a human readable document form. It is possible to read and reconstruct backward the original data form of the document thereof. A favourable embodiment of the invention according to this aspect consists in extracting of the data contents, or a part thereof specified for protection from the file dedicated for printing by the original application. These data will be transformed by a collection of algorithms including a compressing, encryption, self-correction coding, electronic signature, time marking. The data specified for modulation of the protected document (such as logo, graphical patterns, state sign etc.) will be transformed further to the form and format of the collection of symbolic data marks.

Further, these data will be transformed to a format for printing of symbolic data marks according to other aspects of this invention. Consequently, the whole collection of symbolic data marks and the human readable original document form specified for printing on a printing substrate, mostly on paper, will be print overlaid. A protected document will be created thereby. It is possible to sent non standard parts of the document (blank form, logo etc.) from the place of origin by other communication line to a place where the document will be reconstructed, authorised and used.

On the place of usage and authentication (checking), the document will be scanned to insert it in a computer, further, reading of data symbolic marks according to other aspects of this invention will be performed, and a transformation of the detected and extracted data according to the collection of algorithms including the compressing, encryption, self-correction coding, electronic signature, time marking etc. will be performed to reconstruct and authenticate the data recorded in a machine readable form. Further, the data will be merged with the data transmitted by other communication line and the result thereof will be viewed or used for a next processing in a computer on the place of checking or data using. Such a favourable embodiment of one aspect of the invention represents a data channel on the background of human readable data, where such channel assures a data and security continuation by means of the printed document. Such an embodiment represents contrary to OCR techniques 100% data reconstruction on paper and uses mechanisms of the current common technical practice developed for protection of electronic documents.

CLAIMS

1. Method of recording, determination of the location and number of dark elements for coding of dual represented statuses in a symbolic data mark for data recording and reading on paper or other carrier of such mark, wherein these dark elements represent on an area available for one symbolic mark two statuses of a constant number of dark elements which position varies only, which method is characterised thereby that it consists of:

1.1 Determination of the axes of symmetry of a two-dimensional area dedicated for a symmetric data mark, and determination of a co-ordinate system in regard to these axes of symmetry.

1.2 Determination of the aggregate area of the mark i.e. the number of dark elements used for coding of two statuses for data representation on an area allocated for the symbolic data mark.

1.3 Determination of the maximal allowed distance of dark points to a line of equal distance to both the axes of symmetry and minimal allowed distance to each of the axes of symmetry.

1.4 Calculation of the aggregate of the absolute values of both co-ordinates for each possible location of a dark element.

1.5 Determination of the areas of maximal distance to both the axes in compliance with the aggregate calculated in step 1.4 and the condition resulted from step 1.3.

1.6 Recording of one a half of the maximal allowed number of elements in one of the areas determined in step 1.5 within the limits of the area allocated for the symbolic data mark as one a half of a symbol representing one of the two statuses which could be represented by the symbolic data mark.

1.7 Recording of the second half of the maximal allowed number of elements in a next of the areas determined in step 1.5 located on opposite side of both the axes of symmetry within the limits of the area allocated for the symbolic data mark as one a half of the symbol representing one of the two statuses which could be represented by the symbolic data mark.

1.8 Choosing of the location of dark elements located symmetrically to the second symmetry axis with respect to the elements described in step 1.6 and 1.7 as the locations of elements representing the second status of those two representing the symmetric data mark.

1.9 Determination of the areas of maximal distance to each of the symmetry axes individually.

1.10 Recording of the maximal allowed number of elements in one of the areas determined in step 1.9 within the limits of the area allocated for the symbolic data mark as a

symbol representing one of two statuses which could be represented by the symbolic data mark.

1.11 Choosing of the location of dark elements located symmetrically to a symmetry axis that doesn't intersect the chosen locations of dark elements with respect to the elements chosen in step 1.10 as the locations of the elements representing the second status of the two represented by the symbolic data mark.

2. Method of recording according to claim 1, wherein reading of marks and the data status represented thereby on an expected area of paper or other carrier containing dark and light elements and allocated for the symbolic mark is characterised thereby that it involves:

2.1 Evaluation of the status of areas minimally in four corners of a rectangular the dimension of the maximal one allowed for arrangement of the mark in regard to a presence of dark elements in a number greater than a certain threshold p.

2.2 Determination of one status from the collection of possible statuses of the evaluated areas of the read mark according to an upper threshold number of dark elements presented in the four areas evaluated in the previous step minimally.

2.3 Determination of the data value represented by the symbolic mark in the case of a first sub-collection of statuses of the areas evaluated in step 2.1, which is characterised by a presence of dark elements in an upper threshold number in diagonally opposite areas or in a third of the four evaluated areas also.

2.4 Evaluation of the statuses of four areas located always on the shortest not diagonal connection line between the two areas evaluated in step 2.1 in the case of a second sub-collection of the statuses of the areas evaluated in step 2.1, which is characterised by a number of dark elements presented in an upper threshold number in two not diagonal or in the all four evaluated areas, or those characterised by an underneath threshold number of dark elements in all the four evaluated areas in step 2.1.

2.5 Determination of the represented data value of the symbolic mark in the case of such second sub-collection of the areas evaluated in step 2.1 according to the result of the evaluation of the status of the four areas evaluated in step 2.4.

2.6 Repeating of the previous step sequence for the case of a third sub-collection of the areas evaluated in step 2.1, which is characterised by a presence of dark elements in an upper threshold number in one of the evaluated areas only, starting with step 2.1 but with the centre of the evaluated rectangular moved to the corner area that was evaluated in step 2.1 as an area with dark elements presented in a number above the number p,.

2.7 Determination of the represented data value of the symbolic mark, if repeating of the previous steps initialised by step 2.6 results in the second execution of step 2.6 in a return of the centre of the evaluated rectangle towards the original position of the beginning of the process of reading of the mark.

2.8   Correction of the expected location of the following read symbolic marks according to the results of steps 2.1 till 2.7.

3.   Method of recording according to claim 1, consisting in modulation of the total aggregate quantity value of the dark elements of the symbolic data mark, which is characterised thereby that it consists of:

3.1   Selection of the number of dark elements from an interval from 0 to the maximal allowed number of dark elements, that is appropriate to the quantity value level of the corresponding point of the pattern that is viewed by modulation on the grid of symbolic data marks.

3.2   Adding the number of dark elements selected in step 3.1 onto positions nearest to both the axes of symmetry of the data symbolic mark preferring an even number located symmetrical to both the axes of symmetry.

3.3   Adding of the number of dark elements selected in step 3.1 onto free locations adjacent to the elements representing each data status of the maximal distance to both the axes of symmetry.

4.   Method of recording according to claim 1, consisting in initial localisation of the locations of the beginnings and ends of the rows and columns of symbolic data marks, which is characterised thereby that it involves:

4.1   Evaluation of the scanned field representing the bright value of the image points of the read document in one direction horizontally or vertically, point by point.

4.2   Evaluation of k successive image points from a margin of the paper or other carrier, where a change to an underneath threshold value and back must occur l times with an average periodicity of m points, wherein such a first point with an upper threshold value represents one of the minimum's of the horizontal or vertical co-ordinates, which specifies the origins of the rows or columns.

4.3   Creation of a curve of the minimum's F obtained in the previous step.

4.4   Filtration of the points of the curve F obtained in the previous step by elimination of extreme values through a substitution of the all points by an average of p points which are symmetrically placed around the substituted point of the original curve.

4.5   Creation of a straight line of a linear approximation of the filtered curve.

4.6   Placing of a straight line R parallel to the straight line of the linear approximation the all co-ordinates of which are less than those of the point of the minimal co-ordinate in horizontal or vertical direction.

4.7   Translation moving of the straight line R towards the found points.

4.8   Finding of a first intersection O of the moved straight line R with the filtered curve F of the minimum's from point 4.4.

4.9   Rotating of the straight line R around the point O till a next intersection D with the filtered curve F is found.

4.10   Elimination of the points of the curve F, which are more distant to the straight line R located in the position found in point 4.9 than the distance q, and obtaining a resulting curve S.

4.11   Finding of the nearest point of the curve F to the straight line R in each of point clusters, where these clusters are of an average periodicity of h (vertically) or m (horizontally).

4.12   Repeating of the previous steps in the next three directions i.e. for vertical direction, for the horizontal direction backwards to previous points and for vertical direction backwards to the first executed vertical direction.

4.13   Detecting of perpendicularity and parallelism to each other of the resulted straight lines.

4.14   Correction of a line which isn't neither perpendicular nor parallel to any straight lines of the three left.

4.15   Determination of the margins of the field of the marks according to three straight lines minimal.

5.   Method of recording of symbolic data marks by means of dark and light elements placed on paper or a similar carrier of print information, which method is characterised thereby that it involves:

5.1   Definition of a grid of two systems of axes, a horizontal one and a vertical one, perpendicular to each other, with even or different relative distance in horizontal and vertical direction, on a paper area dedicated for recording of symbolic data marks.

5.2   Determination of the maximal allowed number of dark elements for the symbolic data mark.

5.3   Placing of a one system of symbolic data marks in an area of lines connecting two intersections of each horizontal axis with vertical axes so that one logical status represented by the symbolic data mark has the majority or all of its dark elements placed on a one a half of the mentioned connecting line or close to it, and the second logical status represented by the symbolic data mark has the majority or all its dark elements placed on the second half of the mentioned connection line or close to it.

5.4   Placing of a second system of symbolic data marks in an area of lines connecting two intersections of each vertical axis with horizontal axes so that one logical status

represented by the symbolic data mark has the majority or all of its dark elements placed on a one a half of the mentioned connecting line or close to it, and the second logical status represented by the symbolic data mark has the majority or all its dark elements placed on the second half of the mentioned connection line or close to it.

5.5 Placing of dark elements to positions maximal outlying to the centre of a line connecting intersections of the two systems of axes.

5.6 Such placement of the dark elements of the mark, that they are minimally $\underline{v}$ value distant from the mentioned intersections of the horizontal and vertical axes.

5.7 Such placement of the dark elements of the mark, that they are maximal $\underline{d}$ value distant from a line connecting intersections of the horizontal and vertical axes.

6. Method of recording of symbolic data marks according to claim 5 and the data status represented thereby on an expected area of paper or other carrier containing dark and light elements and allocated for a symbolic mark, which method is characterised thereby that it includes:

6.1 Evaluation of the status of chosen areas on either sides from the centre of an expected horizontal connection line between two intersections of horizontal and vertical axes what concerns of a presence of dark elements and their quantitative values.

6.2 Comparison of the aggregate of the quantitative values of the dark elements located in the chosen areas on a one side from the centre of the mentioned connecting line towards a first intersection of the axes with the aggregate of the quantitative values of the dark elements located in the chosen areas on the second side from the centre of the mentioned connecting line towards the second intersection of the axes.

6.3 Comparison of the aggregate of the quantitative values of the dark elements located in the chosen areas on a one side of the mentioned connecting line with the aggregate of the quantitative values of the dark elements located in the chosen areas on the second side of the mentioned connecting line.

6.4 Determination of the represented data value of the symbolic data mark according to the result of the comparison of the quantitative values compared in step 6.2.

6.5 Determination of the size of the correction of the expected position of the evaluated symbolic data mark, adjacent and near marks, particular in the vertical direction according to the result of the comparison of the quantitative values compared in step 6.3.

6.6 Evaluation of the status of chosen areas on either sides from the centre of an expected vertical connection line between two intersections of vertical and horizontal axes what concerns of a presence of dark elements and their quantitative values.

6.7   Comparison of the aggregate of the quantitative values of the dark elements located in the chosen areas on a one side from the centre of the mentioned connecting line towards a first intersection of the axes with the aggregate of the quantitative values of the dark elements located in the chosen areas on the second side from the centre of the mentioned connecting line towards the second intersection of the axes.

6.8   Comparison of the aggregate of the quantitative values of the dark elements located in the chosen areas on a one side of the mentioned vertical connecting line with the aggregate of the quantitative values of the dark elements located in the chosen areas on the second side of the mentioned vertical connecting line.

6.9   Determination of the represented data value of the symbolic data mark according to the result of the comparison of the quantitative values compared in step 6.7.

6.10   Determination of the size of correction of the expected position of the evaluated symbolic data mark, adjacent and near marks, particular in the horizontal direction according to the result of the comparison of the quantitative values compared in step 6.8.

6.11   Usage of the corrections of the vertical and horizontal expected positions of adjacent marks determined in points 6.5 and 6.10 prior to their evaluation according to the sequence of steps 6.1 till 6.10.

7.   Method of recording according to claim 5 with modulation of an area of a document by modulating marks inserted onto a field of placed symmetric data marks, where the marks are recorded on paper, or by graphical information, which method is characterised thereby that it involves:

7.1   Transformation of a graphical information from the original format of modulating marks to such format that is given by a sub-collection of a grid of symbolic marks specified for inserting of modulating marks and determination of quantitative parameters of individual modulating marks.

7.2   Transformation of the quantitative parameters of individual modulating marks into a sub-collection of the dark elements creating such modulating mark.

7.3   Recording of the collection of the dark elements creating individual data modulating marks on an area near to the points which are even distant to the vertical as well as horizontal axes that determine the location of symbolic data marks according to claim 5.

8.   Method of recording according to claim 5 with searching of the co-ordinates of the beginnings and ends of the rows and columns of the horizontal and vertical lines on which are placed symbolic data marks, which method is characterised thereby that it consists of:

8.1   Evaluation of a plurality of $\underline{n}$ horizontal lines arranged basically throughout the whole vertical length of a margin of dark points, proceeding horizontally from a one margin of the scanned paper, substrate till to a point in which the dark points are presented in a number higher than threshold p_z value.

8.2   Leading a straight line as the result of linear approximation of the all points specified in step 8.1.

8.3   Elimination of the points which are more distant from the straight line of that linear approximation than a distance v_i.

8.4   Leading a new straight line as the result of linear approximation of the points remained after execution of step 8.3.

8.5   Elimination of the points which are more distant from the straight line of the latter linear approximation than a distance $v_{i+1} < v_i$.

8.6   Repeating of steps 8.3 till 8.5 till $v_i < H$.

8.7   Repeating of steps 8.1 till 8.6 in a backward horizontal direction from the second margin of the paper.

8.8   Repeating of steps 8.1 till 8.6 in both vertical directions i.e. in the direction of columns.

8.9   For a selected horizontal direction of evaluation of symbolic data marks (rows), a straight line will be led parallel to the straight line of linear approximation of the expected beginnings of rows in the distance of one a half spacing of the vertical lines of the symbolic data marks location whereon are located symbolic data marks of the first system of symbolic data marks.

8.10   Finding of the first symbolic data mark on the straight line led in step 8.9, in the distance of one a half spacing of the horizontal lines of the location of the second system of symbolic data marks from the straight line of linear approximation of the expected beginnings of columns obtained in step 8.8.

8.11   Finding of next marks according claim 6.

9.   Method of recording according to claims 1 and 5, wherein dark elements can be of next characteristics differentiating them from light elements, which method is characterised thereby that it involves at least one of the following:

9.1   Dark elements having quantitative values or value intervals of a value scale of an arbitrary optical characteristic representing two logical statuses of a data symbolic mark, wherein these dark elements consist of a one or more image elements (pixels)

having a higher quantitative value or interval of the value scale of the optical characteristic chosen for representation of the two statuses.

9.2   Dark elements according to point 9.1, wherein the surroundings of a symbolic data mark is of a quantitative value or interval different from two values or intervals representing two statuses of the symbolic data mark.

9.3   Dark elements with an optical characteristic of a half tone scale.

9.4   Dark elements with an optical characteristic of a colour scale.

10.   System for data recording on paper or other carrier and reading of machine readable marks according to claims 1 or 5, which system consists of:
- means for transformation and formatting of source data to a sequence of digital data embedded in individual symbolic data marks,
- means for coding of such data sequence onto a format consisting of a description of symbolic data mark in the language of the used printing method,
- means dedicated for printing of a record on paper or other printing substrate,
- means of reading of data symbolic marks from paper or other carrier onto a computer,
- means of transformation of read data of the format of data sequence that is represented by individual symbolic data marks,
- means of transformation to the format of data which were the source of symbolic data marks recording or to other chosen format,
- means of a marks modulation by a source graphic pattern.

11.   Machine readable record that involves data symbolic marks according to claims 1 or 5, containing a summary constant number of dark elements trough the whole record, which record is characterised thereby that it consists of:
- record media like paper or other record printing substrate,
- data symbolic marks printed on such record medium, arranged onto a grid on positions by periodically repeating characteristics in the horizontal as well as vertical direction,
- text or graphic print printed in an overlay with data symbolic marks,
- elements of a record modulation performed by a graphic pattern.

12.   Method of preparation of data symbolic marks record according to claim 1 or 5, which method is characterised thereby that consists of a human readable text or graphical patterns in an overlay with data symbolic marks.

13.   Method according to claim 12, which method is characterised thereby that machine readable data symbolic marks contain data that represent human readable data printed on the same substrate or a transformation of such data or pattern readable by a human.

14. Method according to claim 12, which method is characterised thereby that machine readable data symbolic marks contain also an electronic signature of human readable data printed on the same substrate.

15. Method of transparent protection of a document dedicated for printing which is transparent in regard to application as well as to the inherent data contents of the document by means of a field of symbolic data marks particular according to claims 1 or 5, wherein this field is printed overlaid by print of the inherent document, wherein this protection provides selective data and security continuity of electronic and paper document in both directions i.e. from electronic version of the document to form printable on paper and from paper form of the document back to electronic version of the document which consists of some or all of following steps:

15.1 Extracting of a part of data contents dedicated for document protection which can include also a positional information on the printed document from the file dedicated for print by an original application.

15.2 Extracting of other document contents, including also invariable data in a set of documents of the same kind, from the file dedicated for print by the original application.

15.3 Transformation of the data extracted in the first eventually also second step according to a set of algorithms including also cryptographic, compress algorithms and procedures, electronic signature, self corrective coding and data preparation for mark modulation by a graphic information.

15.4 Transformation of the data from step 15.3 to a form suitable for print of a field of two-dimensional symbolic data marks representing the mentioned data, for instance such as described in other items of this invention, but not limited on those only, arranged in rows and columns placed in the print document on a substantial document area, principally independent of the area usable for print of the original document, the complete file data of which were used as input of step 15.1.

15.5 Printing performed by overlaying of a print of the original document that is printed concurrently or in time sequence with the print of two-dimensional data symbol marks on one substrate, mostly on paper.

15.6 Scanning of the printed protected document by a scanner or other similar equipment, and input of the scanned data into computer.

15.7 Processing of the read data of the mutually overlaid print of the original document by the field of symbolic data marks, recognising, extraction of data represented by the field of symbolic data marks.

15.8 Transformation of the recognised and extracted data by a set of algorithms including also cryptographic, decompress algorithms and procedures, electronic signature, self corrective coding (decoding).

15.9 Visualisation of the recognised and processed data, i.e. the part of data contents determined for protection.

15.9 Linking of the recognised and processed data of step 15.8 with the data of other document contents of step 15.2 till to full reconstruction of the file document in its complete form as it was used for purposes of items 15.1 and 15.2, however not limited on complete form only.

15.10 Visualisation of the complete document on a visualising equipment.

Fig. 1

Fig. 2

$$V_E = |C_X| + |C_Y|$$

Fig. 3

A
10	9	8
9	8	7
8	7
7

$\Sigma = 66$

$E_B = 66 / 8 = 8.25$

B
| 10 | 9 | 8 | 7 |
| 9 | 8 |
| 8 |
| 7 |

$\Sigma = 66$

$E_B = 66 / 8 = 8.25$

C
10	9	8	7
9	8
8	7
7

$\Sigma = 66$

$E_B = 66 / 8 = 8.25$

D
10	9
9	8
8	7
7
6

$\Sigma = 64$

$E_B = 66 / 8 = 8.25$

Fig. 4

E
10	9
9	8	7
7	6

$\Sigma = 56$

$E_B = 56 / 7 = 8.0$

F
10	9	8
9	8
8	6

$\Sigma = 64$

$E_B = 58 / 7 = 8.29$

G
| 10 | 9 | 8 |
| 9 | 8 |
| 8 |
| 7 |

$\Sigma = 59$

$E_B = 59 / 7 = 8.43$

H
| 10 | 9 | 8 | 7 |
| 9 |
| 8 |
| 7 |

$\Sigma = 58$

$E_B = 58 / 7 = 8.29$

I
| 10 | 9 | 8 |
| 9 |
| 8 |
| 7 |
| 6 |

$\Sigma = 57$

$E_B = 57 / 7 = 8.14$

Fig. 5

J

10	9	8
	9	8
		8

$\Sigma = 52$

$E_B = 52 / 6 = 8.67$

K

10	9	8	7
9			
8			

$\Sigma = 51$

$E_B = 51 / 6 = 8.5$

L

10	9	8
9		
8		
7		

$\Sigma = 51$

$E_B = 51 / 6 = 8.5$

Fig. 6

10				
9	8			
	7	6		
		5	4	
			3	2

$\Sigma = 54$

$E_B = 54 / 9 = 6$

Fig. 7

Fig. 8

$\Sigma_i \ V_{EP} = 124$

Fig. 9

12	11	10	9	8	
11	10	9	8	7	
10	9	8	7		
9	8	7	6		
8	7				

$\Sigma_i \ V_{EP} = 174$

$\Sigma = 174$
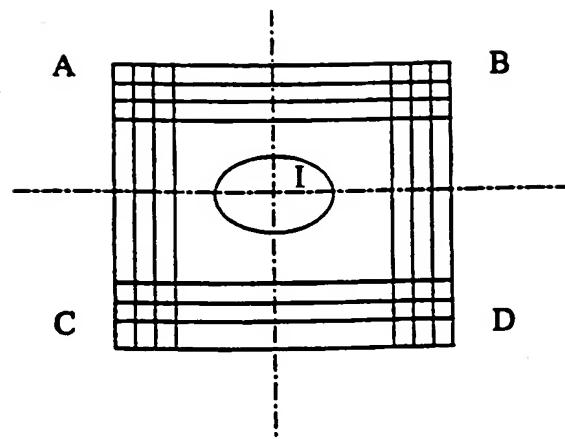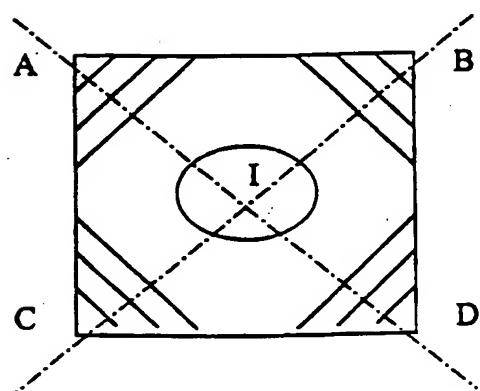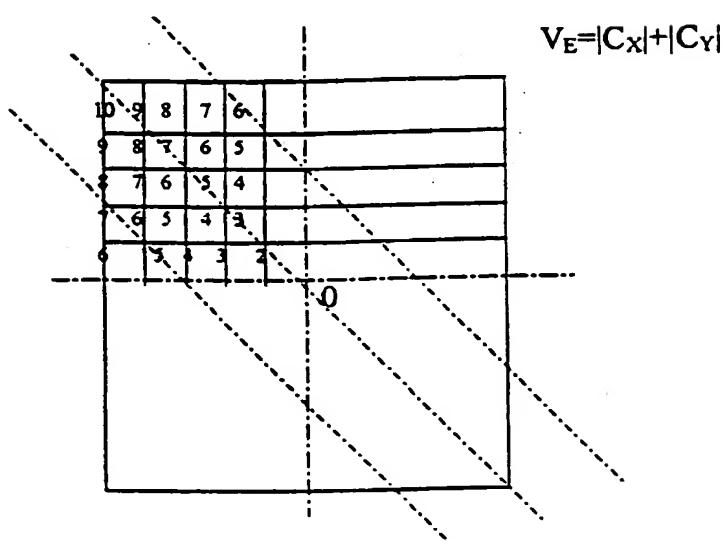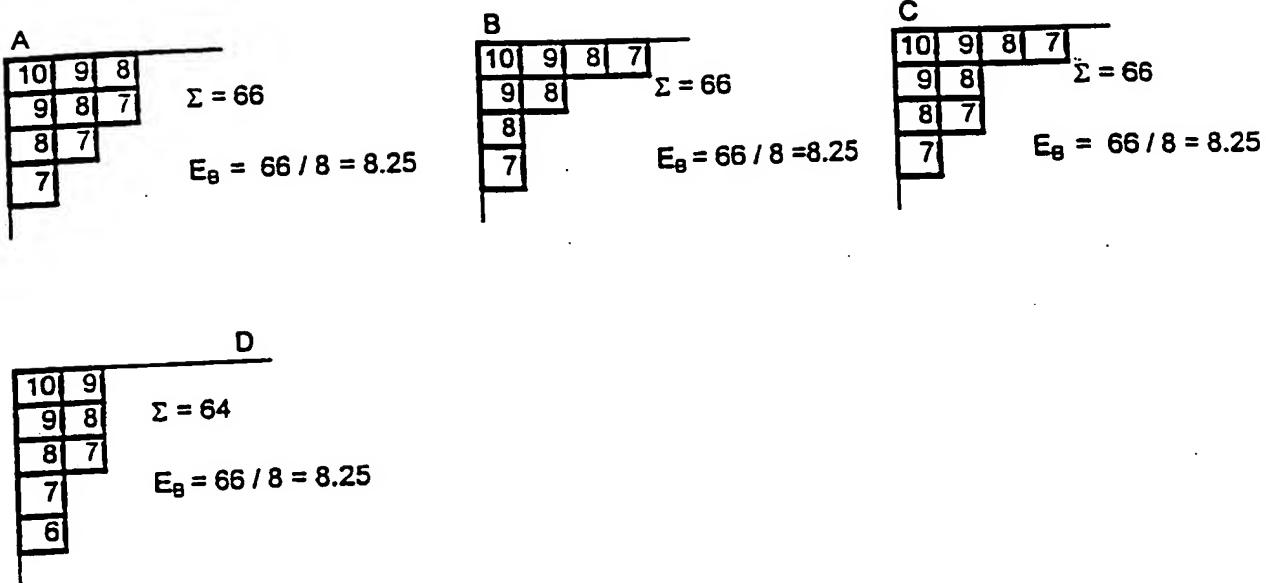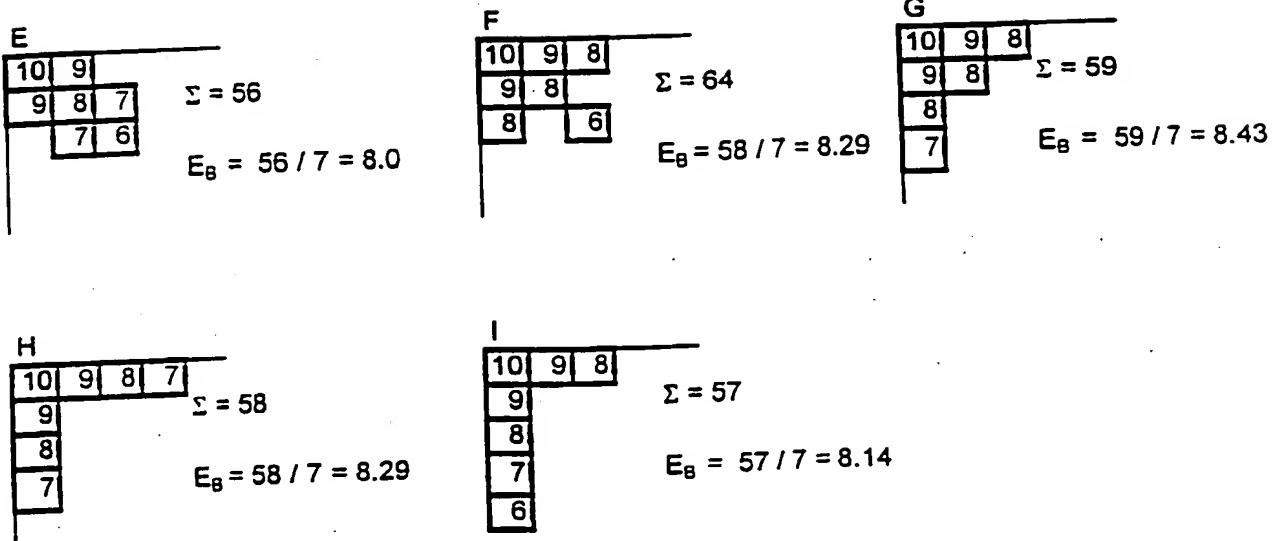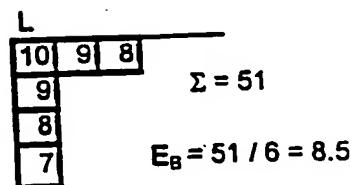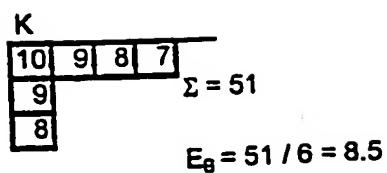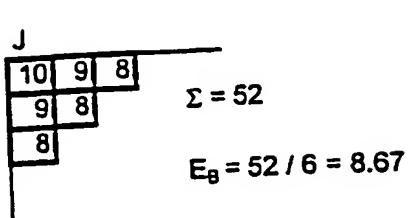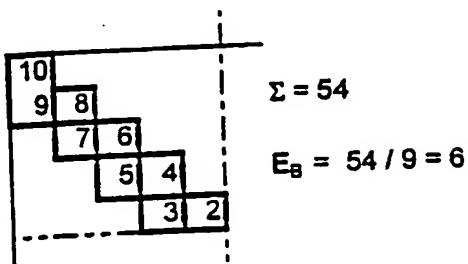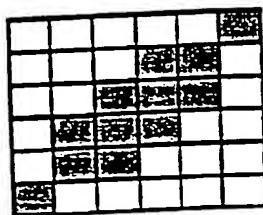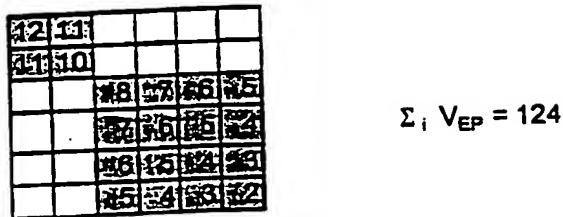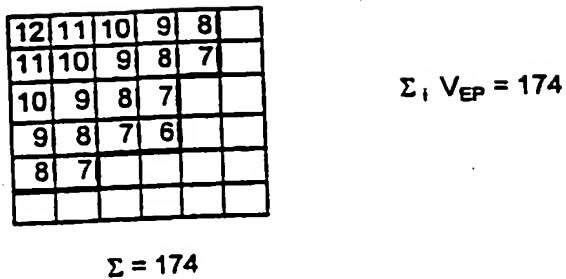
Fig. 10
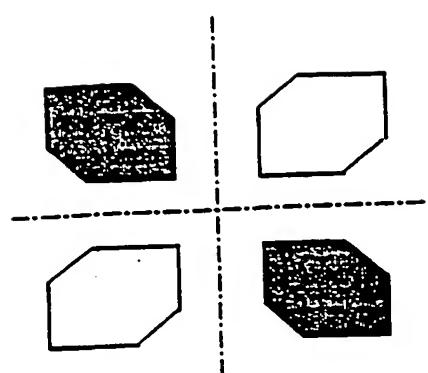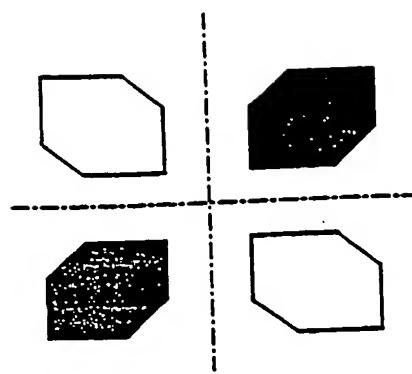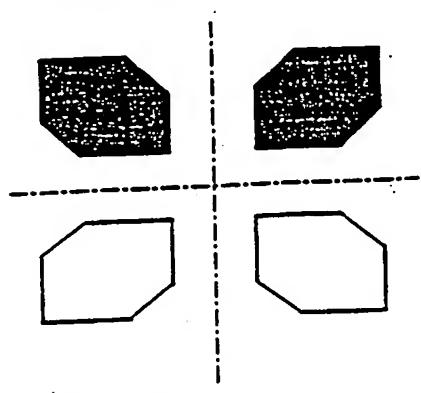
Fig. 11a

Fig. 11b

Fig. 11c
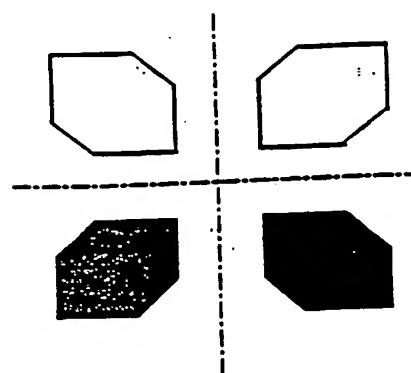
Fig. 11d
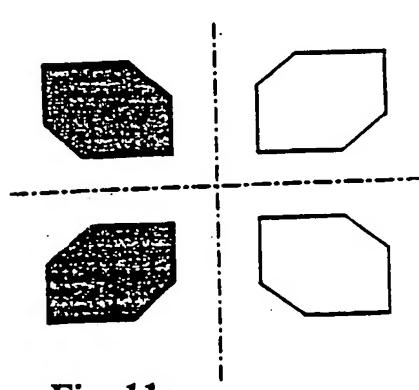
Fig. 11e
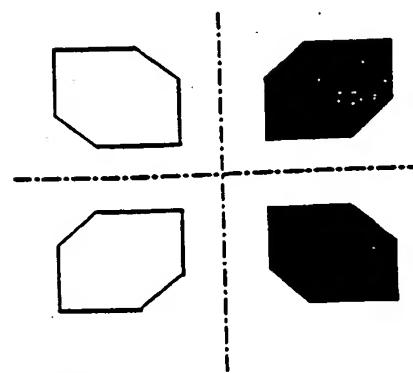
Fig. 11f
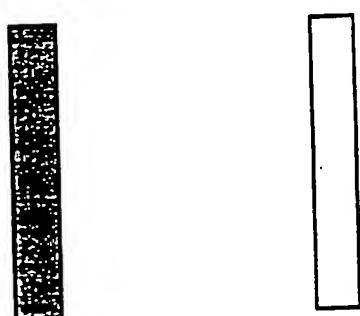
Fig. 11g
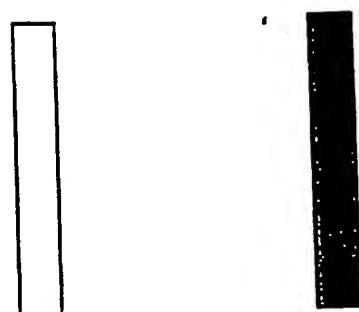
Fig. 11h
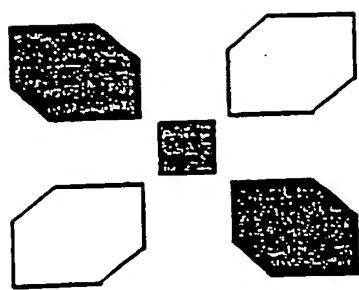
Fig. 12a
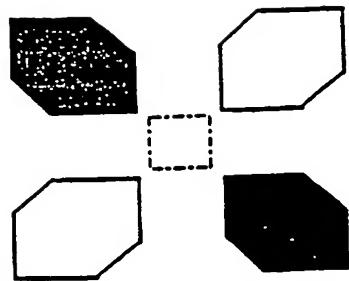
Fig. 12b
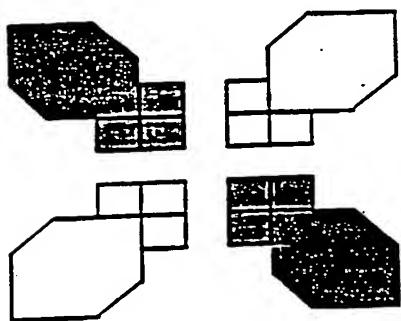
Fig. 13
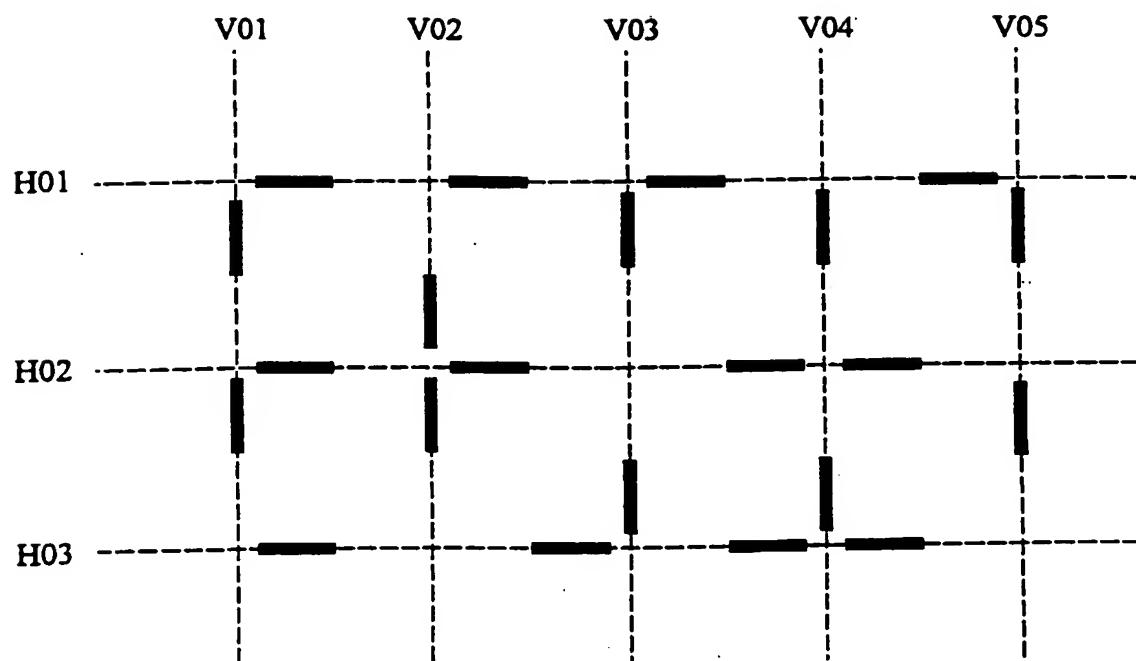
Fig. 14
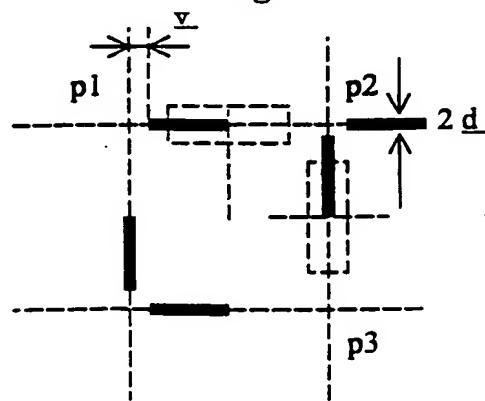
Fig. 15
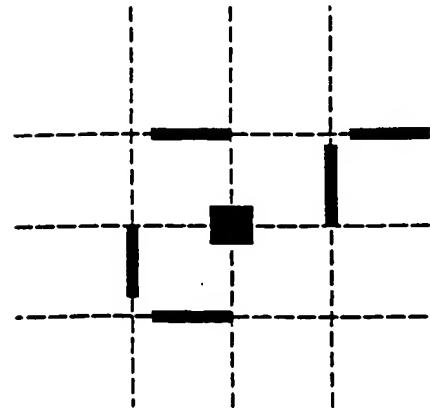
Fig. 16
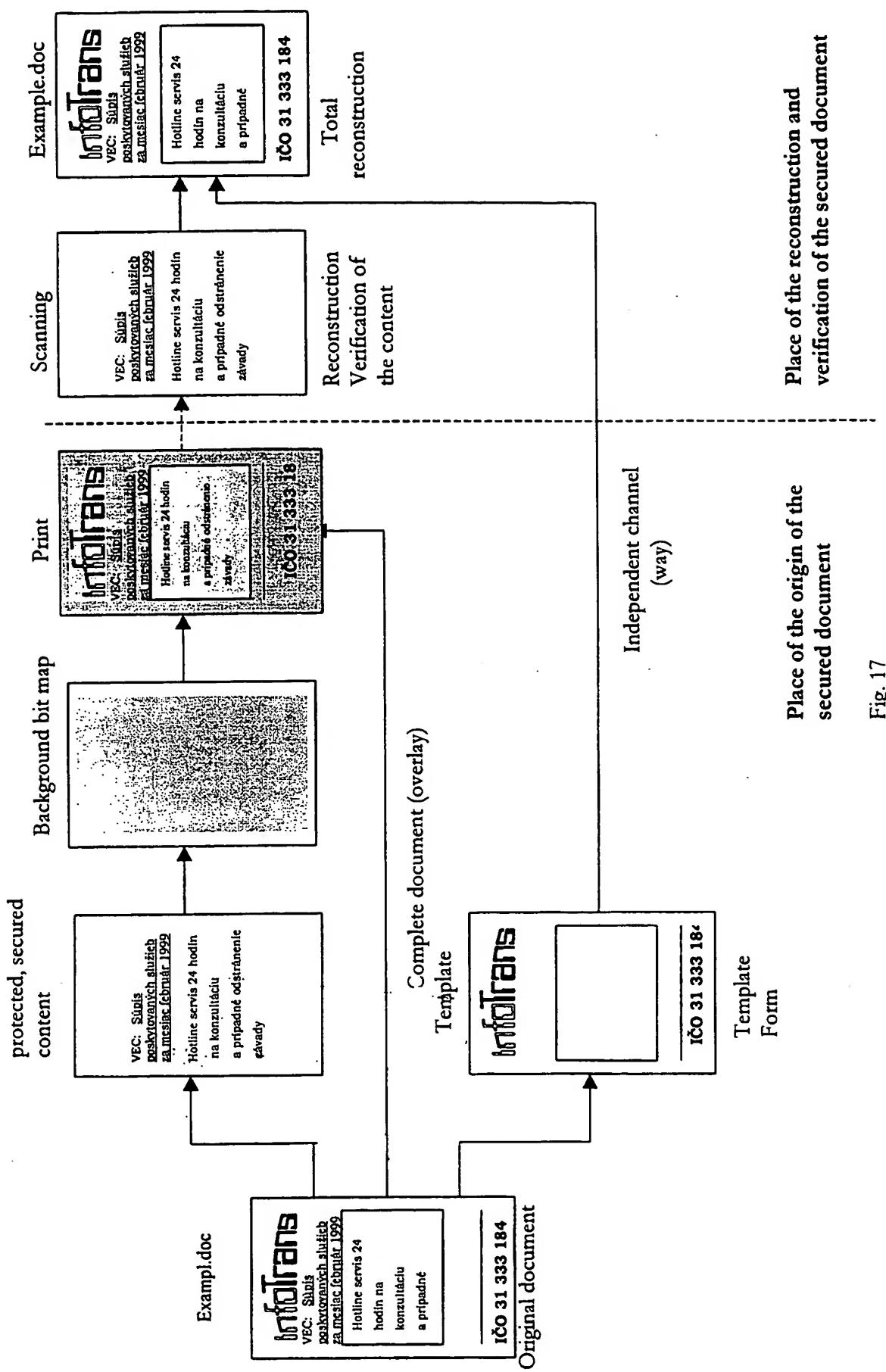
Fig. 17

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   G06K19/06   G06K1/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7   G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 436 974 A (KOVANEN DAVID J) 25 July 1995 (1995-07-25) cited in the application	10,15
A	column 2, line 26 -column 4, line 6 figure 1	1,5,11
A	US 5 541 396 A (RENTSCH FREDERIC) 30 July 1996 (1996-07-30) column 2, line 39 - line 63 figures 1,12	1,5,10, 11,15
A	US 5 245 165 A (ZHANG XIAO B) 14 September 1993 (1993-09-14) column 2, line 3 - line 28 figures 2-5	1,5,10, 11,15

☐ Further documents are listed in the continuation of box C.   ☒ Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 November 2000	01/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Rydman, J

INTERNATIONAL SEARCH REPORT

Information on patent family members

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5436974	A	25-07-1995	NONE		
US 5541396	A	30-07-1996	AT	174142 T	15-12-1998
			AU	668095 B	26-04-1996
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			JP	6502036 T	03-03-1994
US 5245165	A	14-09-1993	JP	5274494 A	22-10-1993